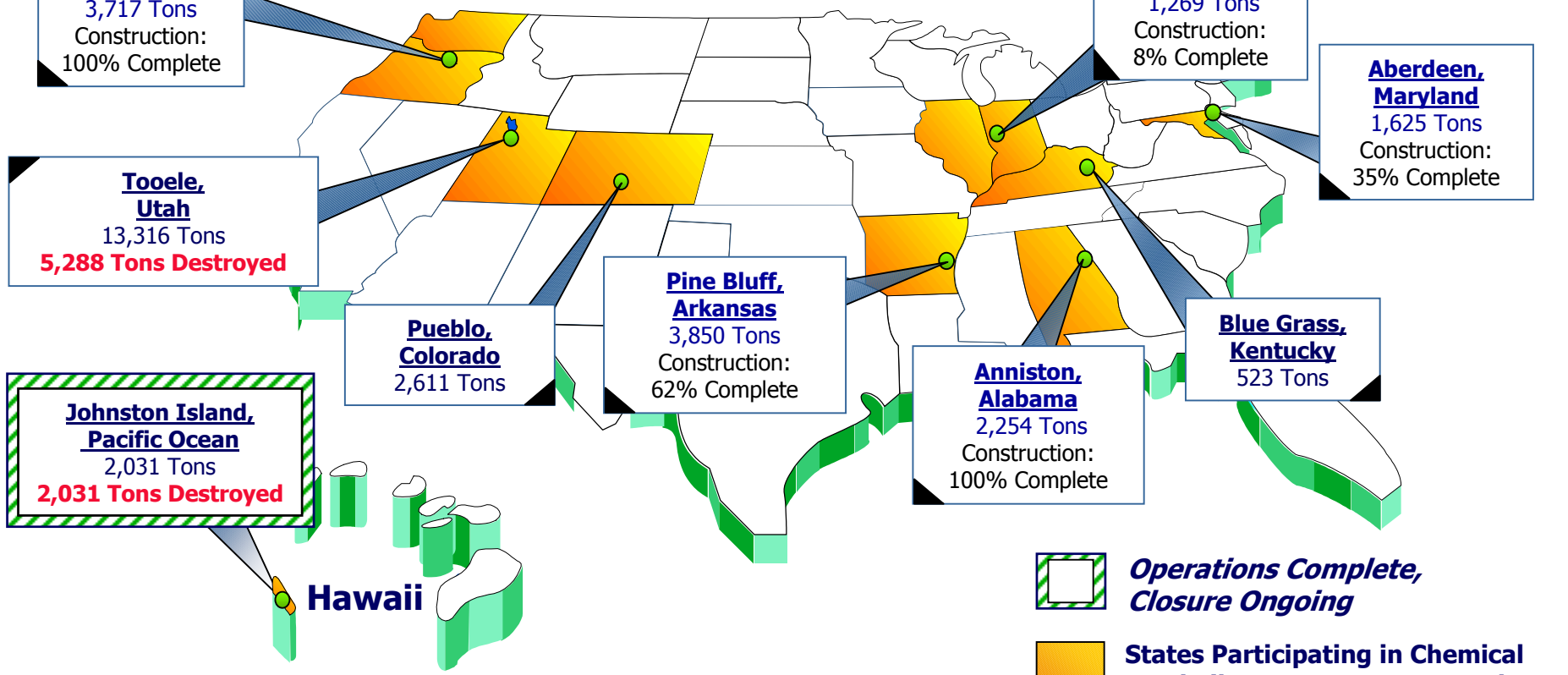
Chemical Demilitarization Program Schedule Risk Assessment

Brian Gladstone, OSD CAIG
Steve Miller, OSD CAIG

January 30, 2002

National Chemical Stockpile

Original Stockpile: 31,496 Tons
Tons Destroyed: 7,319 Tons
As of: 19 Aug 2001



Risk Evaluation Process

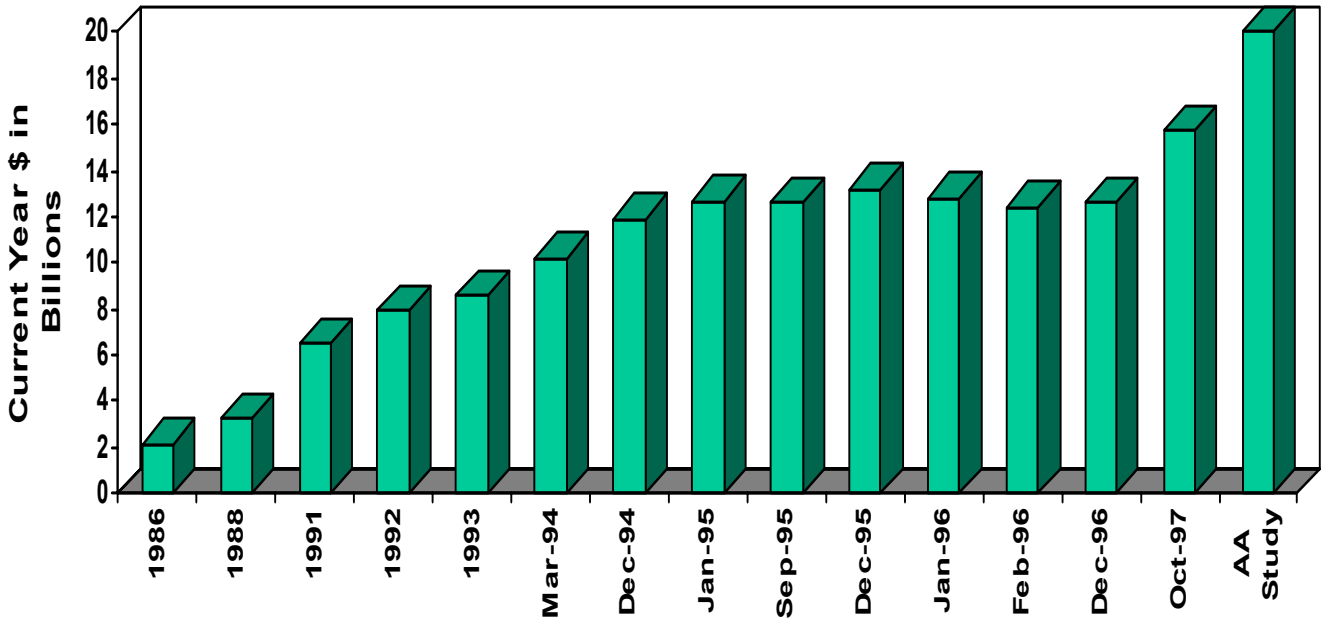
1. Identify risk driver(s)
2. Develop a methodology to quantify the risk elements
3. Brief methodology to stakeholders
4. Collect data
5. Implement methodology and evaluate results

Risk Driver Identification

- **Program had seen tremendous cost growth**
- **Chem-Demil program costs fall into two categories:**
  - **schedule sensitive**
  - **schedule insensitive**
- **Majority of costs were highly correlated with schedule**
- **Schedule has slipped significantly over the years**

Schedule growth had driven cost growth
Estimating schedule was tantamount to estimating cost

Chem Demil Program Cost Growth History



Schedule Problem

1. Each Demil site's process is broken down into 5, primarily, sequential phases
- **Design/Pre-construction**
- **Construction**
- **Systemization**
- **Operations**
- **Closure**

2. Each phase's duration needed to be modeled separately and then combined to capture the schedule stacking correctly

3. Schedule risk varied by phase

Program Office Schedule Estimation Process

1. Based upon process rate studies, actual schedules from other Chem-Demil plants, engineering projections a "most-likely" duration was derived for each phase of each site.

2. Total duration for each site was determined by adding the "most-likely" schedules.

3. Some risk accounted for in determination of the most-likely value

CAIG Observations

1. Probability distribution of the phase durations are highly right-skewed

2. Adding "most-likely" values of skewed distributions does not necessarily lead to the "most-likely" duration for the total duration

3. Some phases have more risk than others

4. Little hard data available to estimate duration distribution parameters

Probability Distribution Selection and Parameter Estimation Process

1. Weibull distribution was selected to model the duration because:

- Classically used to model time random variables (e.g., time to failure in reliability)

- Flexible (varies from an exponential, to a Rayleigh to almost Gaussian) and analytic (easy to simulate)

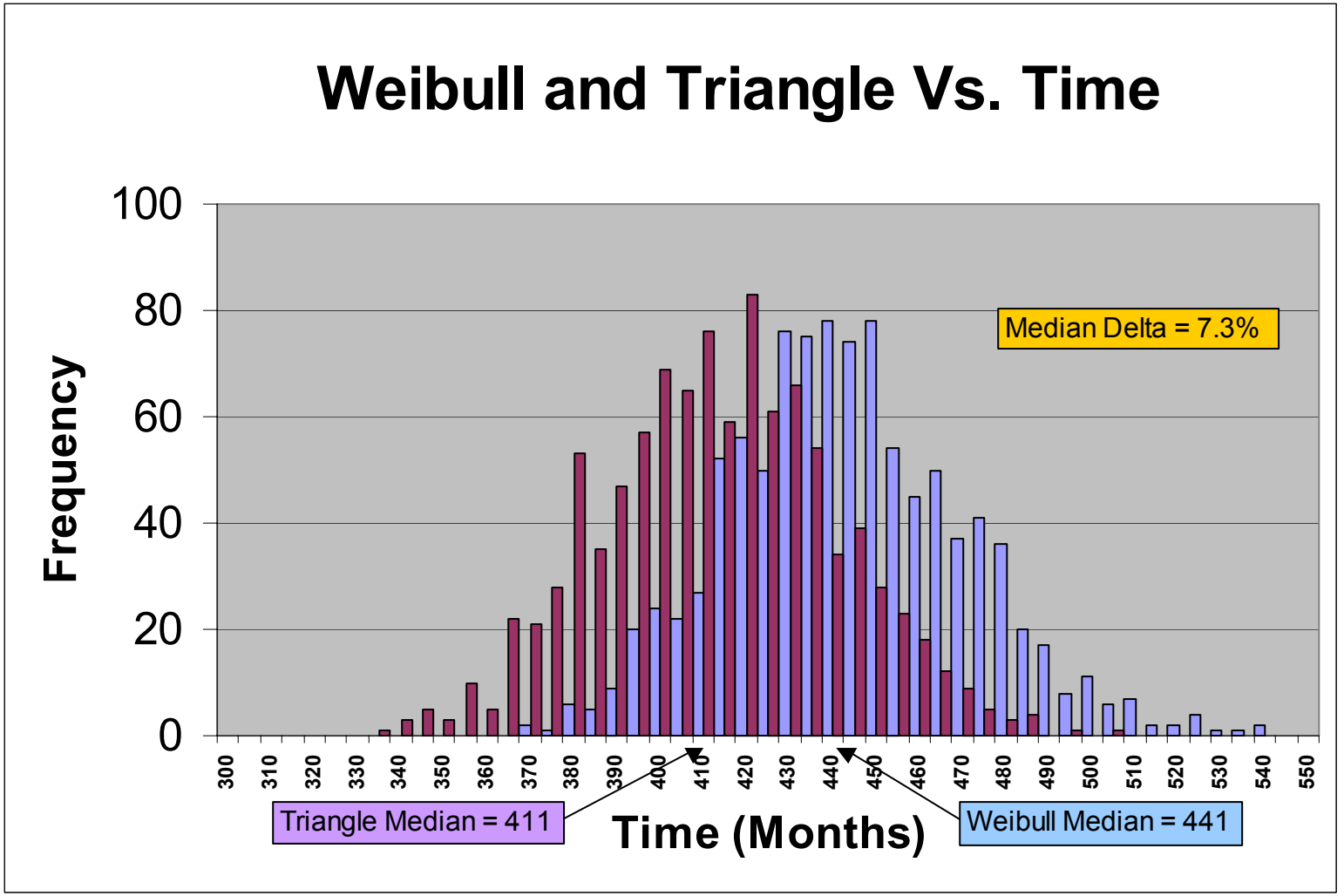
- Parsimonious (3-parameters)

2. Parameter determination process: (need three data points)

- Use most-likely value provided by program office as the mode

- Introduce two quantities Most-Likely/Low and Pr(t>ML)

- Set the values for these quantities depending upon the level of risk (low, medium, high)

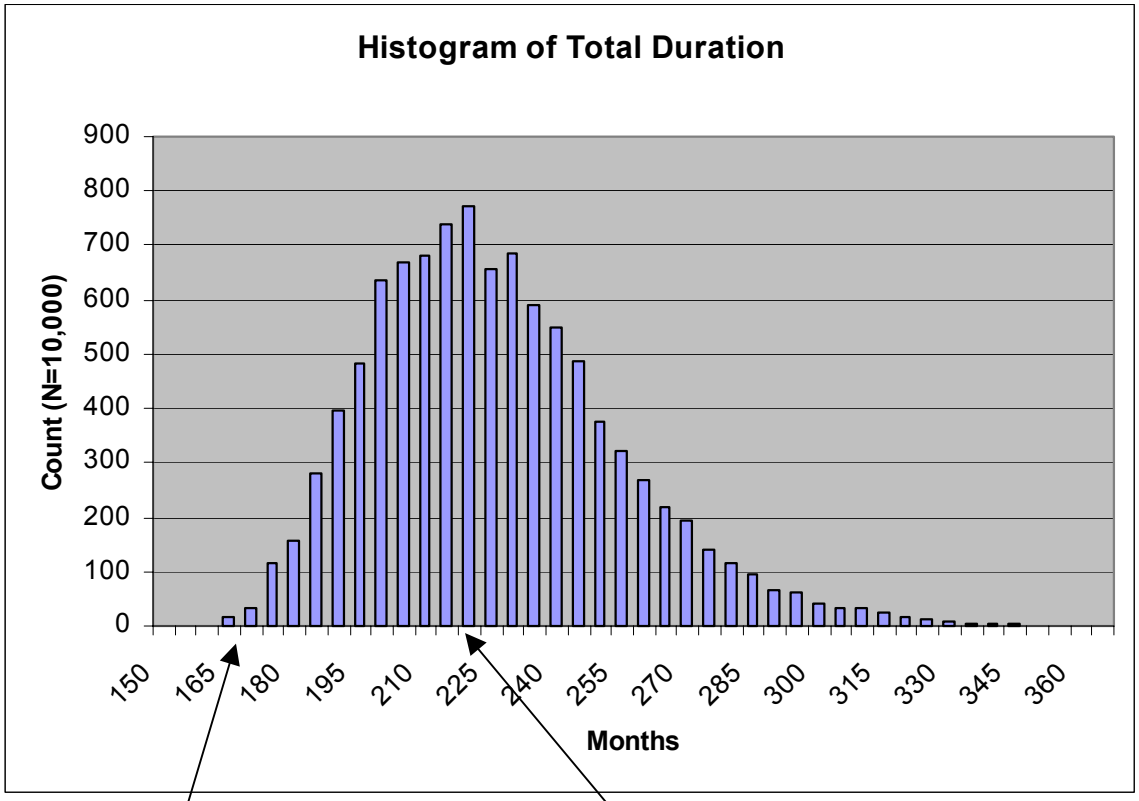

Weibull and Triangle Vs. Time
Frequency
100
80
60
40
20
0
300
310
320
330
340
350
360
370
380
390
400
410
420
430
440
450
460
470
480
490
500
510
520
530
540
550
Median Delta = 7.3%
Triangle Median = 411
Weibull Median = 441
Time (Months)

Example Parameter Estimation Process

Risk Assessment	ML/Low	Pr(t>ML)	Most Likely (ML)	Weibull Parameters			10% Point	50% Point	75% Point	90% Point
Input	By Definition	By Definition	Input	a (low)	b (scale)	c (shape)	Calculated	Calculated	Calculated	Calculated
Low	1.15	0.75	10.00	8.70	3.17	1.40	9.33	11.14	12.69	14.43
Med	1.25	0.80	10.00	8.00	6.41	1.29	9.12	12.82	16.27	20.26
High	1.50	0.85	10.00	6.67	15.27	1.19	8.99	17.90	26.74	37.36

- ML provided by engineering assessment
- Pr(t>ML) and ML/Low are set to span risk space
- Percentiles are used to assess low, medium and high risk is properly reflected

Resulting Distribution



Program Office Estimate
(sum of the individual modes) - 174

CAIG Estimate (50th %ile) - 220

Cost Impact

1. Based upon new schedule, schedule sensitive WBS elements were adjusted

2. Led to a 30% increase over the program office estimate

3. Led to a rephasing of the funding to reflect anticipated slips in resource requirements

Modeling cost as a function of the risk driver was key

Conclusions

- Risk assessment and quantification can often be the most challenging but important element of the cost estimate
- Risk analysis can impact a program resource phasing as well as cost and schedule
- Program optimism (assumptions) can quickly lead to improbable results